# POSTPARTUM INTERVAL OF SOME LOCAL BREEDS OF COWS IN SOUTH DARFUR STATE - SUDAN

**BY**

*MOHAMMED YOUSIF ABDALLA ALFAKI*

*B. V. Sc. ZAGAZIG UNIVERSITY*

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***SUPERVISOR: DR. ADIL SALIM ELSHEIKH***

***Ph. D. HOKKAIDO***

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## Dedication

*To my late father, my merciful,*

*Mother, brothers, sisters.*

*To my beloved wife Amal Mahmood*

*To the lovely eyes of my daughters*

*Soso, Yasmin, Zoba ,Tota and Razan.and also*

*To my relatives and friends.*

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TABLE OF CONTINENTS

# LIST OF FIGURES

## List of Tables

## ABBREVIATIONS

| | |
|---|---|
| APU | Agriculture planning unit |
| BCS | Body condition score |
| BQ | Black quarter |
| CBPP | Contagious bovine pleuro pneumonia |
| CBS | Central Bureau of Statistic |
| CI | Calving interval |
| CL | Corpus luteium |
| COA | Cyclic ovarian activity |
| CRH | Corticotrophin releasing hormone |
| DF | Dominant follicle |
| FAO | Food Agriculture Organization |
| FSH | Follicle stimulating hormone |
| FSH-RH | Follicle stimulating hormone releasing hormone |

| | |
|---|---|
| GH | Growth hormone |
| GnRH | Gonadotropic-releasing hormone |
| HS | Haemorrhagic septisemia |
| LH | Luteinizing hormone |
| LH-RH | Luteinizing hormone releasing hormone |
| MAAR | Ministry of Agriculture and Animal Resources |
| $PGF_2\alpha$ | Prostaglandin $F_2\alpha$ |
| PGS | Prostaglandins |
| PIF | Prolactin inhibitory factor |
| PPI | Postpartum interval |

## List of Appendices

## ABSTRACT

In the present study, the length of postpartum interval (PPI), the effect of season and gonadotropin (GnRH) injection on the length of PPI were studied in some local Sudanese dairy cows native to South Darfur State namely Fellata, Kenana and cross-bred. Furthermore the influences of body condition score (BCS) and parity on PPI were also investigated.

In experiment 1 a total of 59 dairy cows that gave birth were employed to determine the length of PPI. The parity range of these cows was 1 to 5. Their BCS was between 2.5 to 4. The cows were grouped according to their breeds into three groups. Group I was Kenana cows (n = 21), group II was Fellata cows (n = 17) and group III was cross-bred cows (n =21). The PPI was recorded as the time elapse between parturition and the appearance of first oesrtus postpartum. The pure local breeds namely Kenana and Fellata cows had a significantly ($P<0.001$) longer PPI compared to cross-bred dairy cows. The PPI of Kenana, Fellata and cross-bred cows were $286.9 \pm 35.3$ days, $246.3 \pm 26.6$ days and $122.00 \pm 14.9$ days respectively. No differences ($P>0.05$) in the PPI were found between Kenana and Fellata cows. Also a slight negative relation ($R= 0.2$) between BCS and the PPI was observed. Parity has no influence ($R= 0.005$) on PPI, however when parity increases the PPI decreases.

Experiment II was designed to determine the effect of GnRH on the PPI of the above mentioned breeds of cows. A total of 66 dairy cows (Kenana n= 22, Fellata n= 22, cross-bred n= 22) having the same BCS and parity as those in experiment I were used in this experiment. The cows were grouped into two groups. Each group was 33 cows (Kenana n= 11, Fellata n= 11, cross-bred n= 11 cows). Group I was intramuscularly injected with

250 µg of GnRH on day 21 postpartum. Group II was left untreated to serve as control. GnRH treatment significantly (P<0.001) reduced the PPI in all breeds. The PPI of the treated Kenana cows, Fellata cows and cross-bred cows was 79.5± 8.4; 65.9 ± 3.2 days and 74.2 ± 2.8 days respectively. No differences (P>0.05) in PPI among the treated breeds was observed.

Experiment III was designed to study the influences of season of birth on the PPI of the above mentioned cows. The PPI was compared among three groups of cows that gave birth in three different seasons. Group I was 18 cows that gave birth in Summer (Kenana n= 7, Fellata, n=4 and cross-bred n=7). Group II was 19 cows that gave birth in Autumn (Kenana n= 9, Fellata n= 6 and cross-bred n=4) and group III was 31 cows gave birth in Winter (Kenana n= 13, Fellata n= 11 and cross-bred n =7). The BCS and parity of these cows were similar to those of the above experiments. The results showed that the PPI of cross-bred cows was significantly (P<0.001) shorter in Summer. No difference (P>0.05) in PPI of cross-bred cows that gave birth in Winter and Autumn was observed. Neither the PPI of Kenana nor that of Fellata cows were influenced by season (P>0.05). It is concluded that the mean PPI of Kenana, Fellata and cross-bred cows in South Darfur State were 286.9 ± 35.3 days, 246.3 ± 26.6 days, 122.00 ± 14.9 days respectively. GnRH injection on day 21 postpartum reduces the PPI of the three breeds of cows. Additionally, the PPI of the cross-bred cows is only influenced by Summer season. However season has no effect on the PPI of pure local cows.

# موجز الأطروحة

أجريت هذه الدراسة لتحديد طول فترة النفاس (PPI) وتأثير فصل السنة (season) وحقن الهرمون المحرر لمنشطات المناسل (GnRH) على طول فترة النفاس في ثلاث سلالات من أبقار اللبن الموجودة بولاية جنوب دارفور وهذه السلالات هي أبقار كنانة وفلاتة وهجين بين الكنانة والفريزيان. وأيضاً تمت دراسة تأثير درجة الحالة الجسمانية (BCS) وعدد مرات الولادة (Parity) على طول فترة النفاس (PPI).

في التجربة الأولى استخدمت 59 بقرة حلوب والدة حديثاً لتحديد PPI وتأثير عدد مرات الولادة ودرجة الحالة الجسمانية على PPI. عدد مرات الولادة في الأبقار التي تم استخدامها يتراوح ما بين 1-5 مرات ودرجة الحالة الجسمانية لهذه الأبقار ما بين 2.5 -4 وتم تقسيم هذه الأبقار إلى ثلاثة مجموعات. المجموعة الأولى أبقار كنانة(عدد= 21 بقرة)، المجموعة الثانية أبقار فلاته (عدد=17 بقرة) والمجموعة الثالثة أبقار هجين (عدد =21 بقرة). طول فترة النفاس سجلت على أنها الفترة الزمنية التي تمر منذ الولادة حتى ظهور أول شبق عقب الولادة. أظهرت السلالات المحلية (تحديداً سلالتي الكنانة والفلاتة) فترة نفاس أطول من فترة النفاس في سلالة الهجين ($p<0.001$). طول فترة النفاس لأبقار الكنانة، الفلاتة والهجين كانت $122.00 \pm 14.9$, $286.9 \pm 35.3$ , $246.3 \pm 26.6$ يوم على التوالي. كما لوحظ عدم وجود أي فروقات معنوية ($P>0.05$) في طول فترة النفاس بين سلالتي الكنانة والفلاتة. وكذلك لوحظ وجود علاقة سالبة ($R=0.2$) بين درجة الحالة الجسمانية وطول فترة النفاس. وأن عدد مرات الولادة ليس له تأثير ($R= 0.005$) على طول فترة النفاس. ولكن كلما زاد عدد مرات الولادة كلما قصر طول فترة النفاس.

أجريت التجربة الثانية لدراسة أثر حقن الـ GnRH على طول فترة النفاس PPI في الثلاثة سلالات سالفة الذكر. استخدمت في هذه التجربة 66 بقرة (كنانة =22 بقرة، فلاتة=22 بقرة والهجين=22بقرة). درجة الحالة الجسمانية لها BCS وعدد مرات ولاداتها parity كما في التجربة الأولى. قسمت هذه الأبقار إلى مجموعتين كل مجموعة بها 33 بقرة (كنانة=11،

فلاتة=11 والهجين =11). المجموعة الأولى تم حقنها عضلياً ب µg 250 من GnRH في اليوم الـ 21 عقب الولادة. والمجموعة الثانية تركت بدون حقن كشاهد.

أثبتت هذه الدراسة أن الحقن بـ GnRH يقصر طول فترة النفاس معنوياً ($p<0.001$) في كل السلالات وكان طول فترة النفاس في أبقار الكنانة المعالجة والفلاتة والهجين 8.4 ± 79.5 يوم 3.2 ± 65.9 يوم و2.8 ± 74.2 يوم على التوالي ولم تلاحظ أي فروق معنوية ($P>0.05$) وسط السلالات المعالجة بالهرمون.

أجريت التجربة الثالثة لدراسة تأثير موسم الولادة (season) على طول فتر النفاس في السلالات سالفة الذكر. قورنت فترة النفاس بين ثلاثة مجموعات من الأبقار ولدت في ثلاثة فصول مختلفه. المجموعة الأولى وعددها 18 بقرة ولدت في الصيف (كنانة=7 ، فلاتة=4 والهجين =7 بقرات). المجموعة الثانية عددها 19 بقرة ولدت في الخريف (كنانة =9،فلاتة =6 والهجين =4 بقرات). والمجموعة الثالثة وعددها 31 بقرة ولدت في الشتاء (كنانة =13، فلاتة=11 والهجين =7 بقرات). كانت درجة الحالة الجسمانية لها وعدد مرات الولادة فيها كما في التجربتين السابقتين. أظهرت نتائج هذه التجربة أن طول فترة النفاس في الأبقار الهجين تقصر معنوياً ($p<0.001$) في فصل الصيف. كما لم يلاحظ أي اختلافات معنوية ($P>0.05$) في طول فترة نفاس الأبقار الهجين الوالدة في فصلي الشتاء والخريف. كما لم تتأثر أي من فترة نفاس أبقار الكنانة والفلاتة بفصول السنة ($P>0.05$).

خلصت هذه الدراسة إلى أن طول فترة النفاس لأبقار الكنانة والفلاتة والهجين الموجودة بولاية جنوب دارفور هي 35.3 ± 286.9 يوم ، 26.6 ± 246.3 يوم 14.9± 122.0 يوم على التوالي. وأن حقن GnRH في اليوم الـ 21 بعد الولادة يقصر طول فترة النفاس في هذه السلالات. وأيضاً أن فصل الصيف يقصر طول فترة النفاس في أبقار الهجين فقط. ولا تتأثر طول فترة نفاس السلالات النقية المحلية بفصول السنة.

# INTRODUCTION

South Darfur State of Western Sudan comprises 135000 square kilometers of semi arid and savannah zones, and lies within the area defined by the coordinate, Latitude 13°- 9:30 north and Longitude 27°- 24:30 east. It has common boarders with North Darfur, West Kordofan, West Darfur and also North Baher Elgazal State. It also has a shared boarder with Chad and Centeral Africa Republics.

The human population of South Darfur State is about 3.171 millions (CBS, 2004), who are mainly traditional farmers and livestock owners (80% of the total population) live stock producers in the area are nomad, transhumant and sedentary. Nomads and transhumant annually move with their animals from South to North of the state at the beginning of the rains avoiding biting insects and mud in the South. The live stock provides food and capital for human welfare and economic development. South Darfur State is one of the richest states in the country; it is well famous with the natural resources according to its geographical location between the poor Savanna to the North, and the rich Savanna to the South, as well as the Mediteranian climate of Gabal Mara area.

The annual rainfall lies between 300 - 900 mm a year increasing from North to South (Meterological office Nyala station, appendix .1.). The livestock population is estimated as 10 million head according to the Regional Ministry of Agriculture and Animal Resources figures (1993), table .1. and appendix .2.

Table .1. Population of livestock in South Darfur State

| SPECIES | No | Percentage/ total population of the Sudan |
|---|---|---|
| Cattle | 3.476.516 | 10% (34.276.616) |
| Sheep | 3.548.022 | 8.37% (44.350.275) |
| Goats | 2.519.445 | 6.9% (35.992.071) |
| Camels | 69000 | 2.3% (3.019.348) |
| Equines | 300.000 | 3% (10.000.000) |

South Darfur State is the richest state in the Sudan according to the population of animals. The cattle in this state have special properties which became very famous locally and nationally, it is known as Nyala Cattle, or Nalaweyan cattle referred to the name of the capital of the state (Nyala).

The cattle in this state originate from the zebu cattle which is known in the Sudan as Buggara cattle which has the following proparities: -

1. It is a dual purpose cattle for meat and milk production.
2. It is highly resistant to the diseases specially tick born diseases.
3. It has excellent resistance against the external factors and can move for long distance for food and water.
4. It has the ability to stay in very bad conditions and under poor feeding.
5. It has the ability to increase rapidly in weight under favorable conditions.

There are different types of breeds of cattle in the state including:-

1. Local breeds which are known as Nalaweyan cattle.
2. Kenana breed.
3. Cross-bred.

The Local breeds in the state including:-

A. Rizagat cattle: which are red in colour, small in size, with less milk production and can move for long distances.
B. Fellata cattle: It is mainly white in colour, large in size and comparatively with more milk production. This breed is owned by Fellata tribe, Banihalpa, Taisha, Targam, Birgid, and Dago, tripes.

Kenana breed is introduced firstly to the state by AL Gazala Gawazat Research Center to improve the local breeds around the project area 1964, (Sideg Ibrahim Yahia) (personal communication).

Cross-breeds were introduced recently (1991) to the state specifically in Nyala City by Mr. Kamal Adeep and in Mara Mountain, by Mr. Dirag. (personal contact) The cross breeds are mainly kept for milk production. They were a result of crossing between imported Friesian bulls with the local Kenana breed in the state. Recently there is a trend to improve the local breeds for milk and meat production.

In South Darfur State the dairy cattle constitute a very small proportion and the rest are dual-purpose. With such small population of dairy cattle, the production of milk and its products for consumption does not meet the demand. To meet this demand, regular calving at an optimal Interval of about 365 days is desirable as it results in more calves being born, increase the life time, milk production per cow and maximize income (Galina and Arthur, 1989).

Although the indigenous zebu cattle are more adapted to the local tropical environment, their capacity for milk production is usually low (Vaccaro, 1974). Selection for high milk production within the indigenous cattle requires along term genetic improvement programme.

Ageeb, and Hillers (1991) reported that, the indigenous breeds in developing countries generally produce relatively little milk, and there are additional important constraints affecting the production like, quality/ quantity of feed, direct and indirect climatic factors and husbandry practices.

It is generally believed that a calving interval of 12 months is an ideal goal for economic dairy cattle production. This goal can not be achieved unless that postpartum interval (PPI) to first oestrus in dairy cows is reduced. The zebu cattle namely Bous indicus pocess a long PPI (Osman and Eladin, 1971). The local dairy cows native to South Darfur State belongs to this group of cattle. However sparse information about the length PPI of dairy cows in the Sudan is available (Elzubeir, 2003; Elhag, 2003; Elsheikh and Ahmed 2005). This information was for cross-bred dairy cows only. Unfortunately the PPI of the pure local dairy cows is not authenticated in the Sudan. Therefore the objectives of the current study were:-

A. The general objectives were:-

1. To determine the length of the PPI of the local dairy breeds of cattle in South Darfur State, including the Fellata breed, Kenana breed and cross-bred.
2. To determine the effect of parity and BCS on the length of the PPI.

3. To determine the effect of GnRH injection on day 21 postpartum on the length of the PPI.
4. To study the effect of the season of parturition on the length of the PPI in the above mentioned breeds.

B. The main objectives were:-

1. To reduce the length of the PPI of the local dairy breeds of cows in South Darfur State of Western Sudan, aiming to make the cows more productive giving a calf every year, to be more economic and to give more milk to face the demand of the fresh milk specially in the dry season where the nomads and semi nomads move with their cattle to the South and Western parts of the state.
2. To implement the regimen described by Elzubeir and Elsheikh (2004) for management of postpartum period by injecting GnRH on day 21 postpartum.

# 1. Literature Review

## 1.1 Oestrous cycle

Oestrous cycle is divided traditionally into five phases.

1. pro-oestrous phase: it is the phase preceding oestrus. It is characterized by marked increase in activity of the reproductive system. There is follicular growth and regression of the corpus luteum of the previous cycle.
2. The oestrous phase: it is the period of acceptance of the male. The female seeks out male and stand for it to mate her. The ovulation occurs during this phase in all domestic animal species except the cow, where it occurs about 12 hours after the end of oestrus. The main hormone produced during oestrous phase is oestrogen.
3. Metoestrous phase: this is characterized by luteinization of the granulosa cells of the ovulated follicle to form the corpus luteum. During this phase there is reduction in the amount of secretions.
4. Dioestrous phase: during this phase the corpus luteum is fully functional and secreting large amount of progesterone.

5. Anoestrous phase: during this phase the genital system remains quiescent, and this phase is only recognized in seasonal breeders.

### 1.2 Signs of oestrus

Great variations in the intensity of heat signs exist among cows. The manifestations of heat signs tend to be more marked in heifers than in cows. The cow is said to be in oestrus when it stand to be mounted by other cows or bulls (Arthur, *et al*. 1998).

The cow on heat is restless and it shows evidence of bellowing (Arthur, *et al.* 1998). There is a reduction in milk production as results of a reduction in the time spend for eating, rumination and resting (Hafez, 1993). The same author reported that: the oestrous cow licks and sniffs the perineum of other cows, jumps on cows and mounts the bull before standing to be mounted. There is a transparent clear genital discharge from the vulva. The cow shows evidence of pelvic thrusting after full response to the bull and stand with arched back and raised tail. This posture indicates that mating has occurred. In order to improve production in cows it is necessary to achieve a 12 month calving interval. To reach this goal, cows must cycle and become pregnant by an average of 85 days postpartum (Galina and Arthur, 1989; Dimmick, *et al.*, 1991). It was reported that long postpartum anoestrus over 120 days is a very common reproductive problem in primiparous cows under tropical environment (Elhag, 2003; Elshiekh and Ahmed 2005). Although cattle are polyoestrus through out the year, the interaction of the calf with the mother cow was reported to delay the onset of the oestrous cycle (Vicker, *et al.*, 1989). It was also reported by Williams (1990) that temporary weaning of calves reduces the interval to the first oestrus.

The duration of oestrus can be influenced by the breed of the animal, season of the years, presence of bull, level of nutrition, milk yield and number of cows that are in oestrus at the same time (Arthur, *et al*. 1998).

### 1.3 Silent heat or Suboestrus:-

Some cows and heifers fail to show the signs of oestrus, at the same time they have normal cyclical activity, this condition is known as silent heat or suboestrus. This may be due to failure of the herdmen to observe the signs of the oestrous cow. The trained staff plays a major role in dairy farms to detect the oestrous cow (Esslemont and Kossaibati, 2000).The first and the second ovulation postpartum may not be accompanied with behavioral signs of oestrus (Arthur *et al.* 1998). The silent heats are very common in Winter than in Summer months. The postpartum anoestrus in cows is reported to be due to failure of ovulation (Savio, *et al*. 1990).

### 1.4 Postpartum Interval (PPI)

#### 1.4.1 Definition:

Generally it is known as the period from the day of parturition till the appearance of the signs of the first oestrus postpartum. It is also defined by Malvern (1984) as the period required for recovery of the brain, pituitary, ovaries and genital tract functions after pregnancy and parturition. It was found that 90% of dairy cows start oesrtous cycle by 60 days after calving which is the optimal period for the reproductive system to restart its activities for the oestrous cycle, conception, pregnancy, and to give a calf every year (Youngquist, 1988). The time elapsed from parturition until the first postpartum oestrus is accompanied by ovulation and it could be as short as 15 days or longer than 100 days (Malvern, 1984; MacMillan and

Thatcher, 1991). A long PPI over 120 days is a common reproductive problem under tropical condition, (Elhag, 2003; Elsheikh and Ahmed, 2005). The major problem that limits the improvement of reproductive efficiency of dairy cows reared under tropical conditions was the long PPI (Short, *et al*. 1990; Williams, 1990). The Sudanese cross-bred dairy cows have along PPI a round 162. 90 ± 2.70 days (Elhag, 2003). The prolonged PPI is attributed to the absence of LH pulses, which lead to atresia of the developing follicles postpartum (Yavas and Walton, 2000). The same authors reported that injection of GnRH early postpartum can initiates the postpartum ovarian cyclicity.

Herdmen and Shepards in South Darfur State observed that the length of the PPI of the local breeds of cows kept under range conditions are above the optimum rang. Also dairy cows in South Darfur Cities were observed to have a long PPI.

### 1.4.2 Postpartum changes

#### 1.4.2.1 Uterine involution:-

Uterine involution is defined as the reduction in the size of the genital tract to its normal non-pregnant size and function after parturition. The diameter of the previously gravid horn is halved by five days and it's length is halved by 15 days (Arthur *et al*. 1998).

In this phase there is uterine discharge and the time taken for complete uterine involution ranged from 26-52 days in dairy cattle (Michiel, *et al*. 1999). The uterus return to it is pregravid size within 3-7 weeks depending on the myometral contraction, elimination of bacterial infection and regeneration of the endometrium. (Arthur, *et al*. 1998)

The cervix constricts rapidly postpartum, within 10-12 hours after normal calving and by 96 hours can admit only two fingers (Arthur, *et al*. 1998).

### 1.4.2.2. Regression of endometrium:-

Arthur, *et al*. (1998) reported that there is early necrotic changes in the septal mass of the caruncle within the 48 hours postpartum. The same authors mentioned that, complete regression of endometrium occurs soon after parturition in undamaged areas.

### 1.4.2.3 Lochia (Fluid Discharge):-

It is the fluid discharge from the uterus or the genitalia postpartum, it is composed of blood, serum mucous, desquamated epithelium, parts of the fetal membranes, parts of the fetal fluids and leucocytes. It is mucoid in consistency and it is yellowish brown or reddish brown in colour (Hafez, 1993). The discharge of lochia starts on the $2^{nd}$ day postpartum and it reaches the maximum on 6 to 8 day postpartum and then decreases and disappears 14 to 18 days postpartum (Hafez, 1993). The whole puperium in cattle takes 42 days, during this period the genitalia retain to it is physiological condition before pregnancy (Arthur, *et al*. 1998). The high level of $PGF_2\alpha$ after parturition increases the uterine contraction, decreases the uterine size, hasten expulsion of the lochia and expulsion of fetal membranes (Hafez, 1993).

### 1.4.2.4 Elimination of bacterial contamination:-

During the last stage of pregnancy there is small widening of the cervical canal especially when the animal lay down, the pathogenic and non pathogenic bacteria can enter the uterus and rapidly multiply in the favorable media of the uterus. The elimination of the bacteria occurs through phagocytosis and by expulsion of uterine fluids and uterine membranes debris (Hafez, 1993).

### 1.4.2.5 Resumption of the ovarian activities:-

The high level of progesterone secreted by the CL and the placenta during pregnancy exerts continuous feed back effect on the pituitary secretions. After parturition the cow enters a period of postpartum anoestrus, although the progesterone level drops down. The duration of the postpartum anoestrus ranged from 30-67 days for dairy cows, the mean interval from calving to first oestrus postpartum ranged from 33-85 days (Arthur, *et al*. 1998).

### 1.4.3 Factors affecting PPI

The length of the PPI depends mainly on the level of nutrition, body condition score (BCS), suckling, age, season of birth hormonal influences, milking, heat stress and uterine pathology (Short *et al.* 1990; Stagger *et al*. 1998). Early establishment of cyclic activity after calving is essential for maintenance of an acceptable calving to conception interval (Benmard and Stevenson, 1986). Also it was found that dairy cows ovaries rebound within 30 days (lamming, *et al*. 1981). Some dairy cows may ovulate without showing the oestrous behaviors which lead to long PPI (Hafez, 1993).

### 1.4.3.1 Nutrition:-

Nutrition is also among the primary factors that influence the PPI (Mukasa, *et al*. 1991). The metabolic demand for high milk yielding cows should be considered as it has a possible effect on postpartum ovarian activity (Coppock, *et al*. 1974; Butler, *et al*. 1981; Sejresan and Sorensen, 1982; Elkeraby and Abu-Ela 1982). Strategic management of nutrition is also essential for improvement of the reproductive performance of cows (Short *et al*. 1990; Williams, 1995). The length of the postpartum and the reproductive performance of the dairy cows can be affected directly by deficiencies of energy, (Youngquist, 1988). The occurrence of the first postpartum oestrus is influenced by the level of nutrition (Kovacevic, *et al*. 1988). The cows under high level of nutrition during the postpartum period have high incidence of oestrus and ovulation as a result of high level of FSH that increases during follicular phase (Rhind and McNeilly, 1986).

### 1.4.3.2 The Body condition score (BCS)

Paul (1995) reported that the BCS involves tacticle and visual appraisal of the amount of tissues that cover the vertebrae at the lumber region and around the tail head. Veerkamp, (1998) suggested that successive measures of BCS may be useful indicator of energy balance as the short fall in energy obtained from food is believed to come from mobilization of body tissue reserves.

The BCS is used as a subjective method to determine the body reserves of dairy cattle (Paul, *et al*. 1995) the method is based on a visual and tactical appraisal of body fat reserves in the back and pelvic regions. The BCS is usually scored on a scale of 1 to 5. (Wildman, *et al*. 1982).

BCS changes over early lactation, could affect the resumption of oestrous cycles and reproductive success. Loss of BCS has been found to be associated with increased levels of milk production at the phenotypic level ( Pryce, *et al*. 2001).

The cumulative percent of cows exhibiting oestrus by day 20, 40 and 60 postpartum was higher when the cows calved at a BCS of scale grade 4 (Richards, *et al*. 1982). When the level of nutrition was high the cumulative percentage of cows exhibiting oestrus during postpartum period was high. If the level of nutrition is increased during postpartum period the level of FSH increases during follicular phase and results in high ovulation rate (Sejresan and Sorensen, 1982).

**1.4.3.3 Suckling:-**

Suckling was reported as one of the primary factor that determine the length of PPI in cattle (Mukasa, *et al*. 1991). Suckling induces suppression of LH through suppression of LHRH secretion (Lamming, *et al*. 1982; Acosta, *et al*. 1983; Webb, *et al*. 1996).

Stagger, *et al*. (1998) had shown that restriction of suckling to once daily or complete isolation of calf from suckling beef dams induced an earlier ovulation as compared with continuously suckling dams. Restricted suckling was reported to hasten the return to oestrus. The postpartum pituitary responsiveness and ovarian activity are reported to return within 4-5 weeks after calving in beef cows (Mc Natty, 1988). Strategic management of suckling should improve the reproductive performance of cows without decreasing the growth rate of calves (Randel, 1981; Short, *et al*. 1990; Williams, 1990; William and Griffith).

**1.4.3.4 Age:-**

The PPI of old cows tend to be longer than that of heifers and middle age cows (Marion and Gier, 1998). The same authors reported that primiparous dairy cows have longer PPI than the multiparous. The cows reaching their seventh lactation are known to had a poor fertility (Esslemont and Kossaibati, 2000). However, no effect of age on PPI was reported by (Zainelabdin, 2001).

**1.4.3.5 Season:-**

The season has strong effect on the interval between parturition and first oestrus in dairy cows, (Peters and Riley, 1982). It is also found that the interval between calving and first oestrus was longer in Winter and early Spring (Montgomery, 1985). The animals calved in dry Summer season has long calving interval compared to those calved at rainy season.

The breeding season is influenced by environmental and physiological factors that regulating the breeding season. The rain fall and temperatures are considered as environmental factors affecting the season of breeding. Also photoperiodic variations are considered among the major environmental factors that affect the reproductive efficiency. It was found that frequency of oestrus and ovulation, as well as conception rate in Kenyan zebu cattle is higher during the Summer than during the Winter (Rhodes, et *al*. 1982).

**1.4.3.6 Hormonal activity during postpartum:-**

- **FSH:-**

The level of FSH increases in concentration from preparturition to reach high levels postpartum (lamming, *et al*. 1982). This was explained by (Hafez, 1993) by the variable follicular growth and atresia that occur in the preovulatory PPI. The follicular growth with development of mature follicles is prerequisite for LH response and ovulation (Peters and Lamming 1984). Plasma concentration of FSH is also reported to increase during the first 3-5 days postpartum (Lamming, *et al*. 1981; Lamming, *et al*. 1982).

- **LH:-**

Pituitary LH content and responsiveness to GnRH increases rapidly from their lowest at parturition and increases gradually when follicles are recruited postpartum (Malvern, 1984; Schallenberger, *et al*. 1984). The recovery of pituitary LH reserve and its responsiveness to GnRH seems to be nearly completed by day 10 postpartum in dairy cows (Moss, *et al*. 1985). Administration of GnRH stimulates the pituitary gland to induce LH pulses and the LH surge which is responsible for ovulation of the mature follicle (Hafez, 1993).

- **Oestrogens:-**

The level of oestradiol increases from day 26 before parturition and then decreases from day 9 postpartum (Smith, *et al*. 1987). Also oestradiol is necessary for sensitization of pituitary to release both preovulatory FSH and LH. Arthur, *et al*. (1998) reported that oestrogen and progesterone decline from high values during late pregnancy to a very low concentration over the first 4-5 days postpartum. Ginther, *et al*. (1996) reported that the high level of oestrogen and progesterone concentration prior to calving suppresses the follicular waves before calving.

- **Progesterone**

The plasma concentration of progesterone hormone is high during last stage of pregnancy, and then begins to drop in concentration before parturition and remains very low over the first 4-5 days postpartum.

The sudden drop of progesterone following parturition lead to removal of the negative feed back on the gonadotrophins and thus exerts appositive feed back upon the hypothalamus to release GnRH which stimulates the anterior pituitary to release FSH and LH (Savio, *et al*. 1990). It was found that, the progesterone hormone enhances the luteal phase of the next cycle and controlling oestrous cycle (William, *et al*. 1982; Bashir, 1990).

- **Oxytocin:-**

The level of oxytocin reach its maximum level (6.4pg/ml) at the expulsive stage of parturition and falls to the minimum level (0.5pg/ml) at time of oestrus (Hafez, 1993). The oxytocin level during late pregnancy and early stages of parturition remains low and increases to reach the peak values when the fetal head emerges from the vulva. So it plays only minor role in initiation of uterine contractions. The release of oxytocin hormone is stimulated by sensory receptors in the cervix and anterior vagina.

- **Prostaglandins (PG,s):-**

The level of prostaglandins metabolite were high at parturition and they were elevated on the 7 to 23 days postpartum. PG play an important role in uterine involution postpartum (Lindel, *et al*. 1982). PG specially $PGF_2\alpha$ are essential for ovulation and activation of the collagnases that cause weaking of the follicular wall and thus enhances ovulation.

Injection of exogenous $PGF_2\alpha$ during the 1st , the 2nd , or the 4th week postpartum enhanced the uterine involution of dairy cows (Kindahl, *et al*. 1982). Also it was found that administration of PGF2α during the 3rd, the 5th or the 8th week postpartum stimulates early cyclicity in dairy cows (Zemjanis, 1980). Sudanese cross bred cows (Kenana × Friesian) which were given a single or a double injection of $PGF_2\alpha$ during the 1st, 2nd or the 3rd week postpartum, expressed a shorter postpartum period (Elzubeir and Elsheikh 2004). Some authors reported that a single or double injection of $PGF_2\alpha$ during the postpartum period at 10-14 days interval decreases the days open (Youngquist, 1988; Schofield, *et al*. 1999).

- **Prolactin :-**

Prolactin increases 2-4 days before parturition and continues to increase after parturition in both milking and suckling cows (Hafez, 1993). It had been reported that suckling and milking had no effect on prolactin levels (Smith, *et al*. 1987). It was also found that the release of prolactin is under the control of prolactin inhibitory factor (PIF) which is released from the hypothalamus. Prolactin is also an important luteotrophic agent.

- **Insulin:-**

Insulin has a gonadotrophic effect on follicular development. This gonadotrophic effect is exerted through its action on the hypothalamic neurons (Lucy, *et al* 1992; Gong, *et al*. 2002; Gong, *et al*. 1996). In their report they mentioned that insulin has specific receptors located in the hypothalamus. Insulin binds to these receptors and enhancing glucose metabolism inside the neurons. Thus increasing the production of reproduction releasing hormones from the hypothalamus. This was supported by the findings of Gong, *et al*. (2002), who reported that the high insulin including diet reduced the PPI and increased the conception rate in dairy cows.

- **Corticosteroids**

During the final stages of gestation the plasma concentration of cortisol increases. Due to the rapid growth of the fetus and increasing the demand to the metabolic agents this stimulates the placenta to produce $PGF_2\alpha$ which stimulates the fetal hypothalamus-pituitary and adrenal axis leading to increase concentration of cortisol (Hafez, 1993). The cortisol stimulates the placenta to convert progesterone to ostrogen. The elevated level of ostrogen stimulates secretion of $PGF_2\alpha$ from uterine wall and enhance developing of oxytocin receptors.

**1.4.3.7 Milking:-**

Recent studies carried on cows with high genetic merits kept under a grass based production system indicated that they had long interval to first service (Buckley, *et al*. 2000 a and b). High genetic merit is associated with high milk yield. The same above mentioned authors suggested a poor reproductive performance in high milk producing cows, as reflected by a poor conception rate. The high milk yield is reported to have a negative effect on recrudescence of oestrous postpartum (Harrison, *et al*. 1990).

### 1.4.3.8 Heat stress:-

The climatic factors and husbandry practices are important constraints affecting dairy production (Ageeb and Hillers, 1991). The heat stress is the major environmental factor affecting fertility of dairy cows during hot season (Abilay, *et al*. 1975). The Same authors reported that the heat stress reduces plasma oestradiol during pro-oestrus, and affects the length and intensity of oestrous behavior. This explain the smaller proportion of cows detected in oestrus during Summer season (Gwazdauskas, *et al*., 1981). Many alternatives have been made to reduce the effects of heat stress on dairy cows through the use of shade, fans, air conditioning and sprinklers, (Thatcher, 1974; Wise, *et al*., 1988; Johnson, 1991). The heat stress reduces the feed intake, milk production and increase mortality rates. The higher temperature in the tropics is inimical to sustainable dairy production using Bos Taurus, (Vaccaro, 1974; Ansell, 1985; Eisen, 1989). The importation of temperate breeds for cross breeding in Sudan started in 1925. Tendency to keep purebred Holstein- Friesian cow for intensive dairy system has developed in recent years (Osman, 1984).

### 1.4.3.9 Uterine infections

Uterine infections delay the initiation of folliculogenesis (Peters and Bosu, 1988). The uterine infections cause suppression of the rate of follicular growth in dairy cows during early puperum by inhibiting LH release. The same authors found that, the inhibition was due to endotoxins produced by gram-negative bacteria in the postpartum period.

Postpartum uterine infections occur commonly in the cows due to retention of fetal membranes and dystocia (Hafez, 1993). Placental retention accompanied with metritis was known to delay uterine involution (Arthur, *et* *al*., 1998). Pyometra in the cow was reported to develop when ovulation occurs within 3 weeks after calving with presence of large numbers of pathogenic bacteria in the uterus (Olson, *et al*., 1984).

### 1.4.10 Management:-

The poor standard of herd management will lead to poor detection rates of oestrus (Arthur, *et al*. 1998). Therefore a well trained staff for herd management of dairy farms is needed to identify oestrus correctly. The importance of trained staff for herd management was also stated by Esselmont and Kossaibati (2000) who found that the percentage of cows identified in oestrus by a well trained herd staff ranged between 82-97% where percentage of cows in oestrus detected by untrained staff was 67%. There are some constrains like over crowdness and muddy floors which will reduce the accuracy of oestrous detection because cows that are not in oestrus will not be able to escape away from other mounting cows (Arthur, *et al*. 1998).

### 1.4.11 Breed:

The breed is considered to be as the main constrain affecting the reproductive performance of the dairy cows therefore different breeds had a different length of PPI (Ruiz, *et al*. 1992). The genetic influences of the breed can be demonstrated by the short period for the return of ovarian function postpartum in the dairy breeds 10-45 days compared with beef breeds 36-70 days (Arthur, *et al*., 1998). Crosses between Bosindicus and temperate cattle are known to have a relative longer PPI compared to crosses among temperate cattle (Estrada, *et al*. 1992).

**1.5 Biological Uses of Gonadotropin – releasing hormone (GnRH)**

GnRH is a decapeptide hormone synthesized in cell bodies of neurosecretory neurons located in the mediobasal hypothalamus (Arthur, 1998). It stimulate the pituitary gland to release LH and FSH (Thatcher, *et al*., 1991). The GnRH effects can be indirect through its effect on pituitary to release LH and FSH (Chenault, *et al*., 1990) or direct on the reproductive tissues. Two potential gonadotropin responsive tissues within the ovary are the corpus luteum (CL) and the follicle.

Thatcher, *et al*. (1993) reported that the GnRH will not have direct stimulatory or inhibitory effects on CL to increase progesterone production. Thus, potential GnRH effects must be mediated indirectly via alterations in endogenous gonadotropin secretion or directly via non receptor mediated mechanism. The GnRH and its agonist analogues act on ovarian follicular development and CL function indirectly via the induced release of pituitary LH and FSH (Hafez, 1993). Administration of GnRH increase LH and FSH in the peripheral circulation within 2-4 hours (Chenault *et al*., 1990; Stevenson *et al*., 1993). These gonadotropins act directly by binding to their respective receptors on follicular and luteal cells (Mac Millan, and Thatcher, 1991). The GnRH causes inhibition of oestrus and induces ovulation of large follicles. The induction of ovulation of the large follicle is associated with decrease in oestradiol concentration ($E_2$) in the peripheral circulation. Ovulation does not occur in all cases after GnRH treatment because the ability of a follicle to ovulate depends on its developmental stage. The concentration of progesterone decrease <I n mole/ml and the large follicle produces oestradiol that is involved in triggering oestrus via its positive feed back on hypothalamus- hypophsis center (Hafez, 1993). This stimulates the release of the GnRH and induces LH pulses and the LH surge which is

responsible for ovulation of the large follicle. The delay of oestrus following treatment with a GnRH agonist is due to functional alterations of large follicle present at the time of treatment (Twagiramungu, *et al*. 1995).

The GnRH is a potential drug that is used widely in the management of postpartum reproductive efficiency in dairy cows (Fernandez, *et al*., 1978). Administration of The GnRH eliminates the large follicles by ovulation or atresia and initiates new follicular waves within 3-4 days after treatment at any stage of oestrous cycle (Twagiramungu, *et al*., 1995). It is also found that administration of the GnRH to the dairy cows postpartum, reduces the PPI (Thatcher, *et al*. 1993). It is found that the pregnancy rate reached 53.7% for the cows injected with GnRH on the day of parturition (Mialot, *et al*. 1999). The same authors reported that, cows given the GnRH on the day of parturition showed oestrus on day 10. Elzubeir and Elsheikh (2004) reported that, cross bred dairy cows (Kenana × Friesian ) when received an injection of GnRH during the 1$^{st}$ 2$^{nd}$ or the 3$^{rd}$ week postpartum has a similar number of services per conception (1.00 ± 0.00) which were lower than that of the control (1.40 ± 0.20). Moreover the same authors reported that the GnRH treated cows have a shorter days open and calving interval than untreated cows.

The resumption of ovarian activity and oestrus early in the postpartum period can be enhanced by a single injection of GnRH given at different times after calving (Schams, *et al*., 1973; Britt, *et al*., 1977; Irvin, *et al*. 1981; Boiti, *et al*., 1982; Ball and Lamming, 1983).

### 1.6 Calving Interval (CI)

It is the period between two consecutive calving. It was reported that the CI of zebu cattle in North Sudan is 428 days. While that of temperate cows namely Friesian bred in Sudan was a round 360 days (Bashir, 1990). A calving interval (CI) close to 12 month is generally regarded as the most profitable length of the CI in dairy production (Zeddies, 1982; Strandberg and Oltenacu, 1989). This assumption is mainly based on economical calculations on milk production, feeding and housing. The CI is an objective trait of economic importance (Olori, and Galesloot, 2000). Also the CI can be considered as a good indicator of cow fertility (Campos, *et al*. 1997; Pryce, *et al*. 1998).

The CI is influenced by the same factors that influence the PPI

# Materials and Methods

## 2.1 Study area

This study was done in Nyala City which is the capital of South Darfur State of Western Sudan, it lies within the area between latitute 12º: 03º 25¯ N and longitute 24º: 53º 091¯ E, with 671m above the sea.

## 2.2 Climate:-

South Darfur State has three different climates. Semi desert climate with average rain fall of about 100-300mm/year. Poor Savanna climate with average rain fall of about 300-600mm/year. Rich Savanna climate with average rain fall of about 600-900mm/ year.

There are three distinct seasons through out the year. The hot dry Summer season from March to June, rainy season from July to October, and Winter season from November to February.

## 2.3 Temperature measurement:-

The daily temperatures were obtained from Nyala Meteorological Department (appendix .4.)

The mean temperature during Winter is (32.3ºC maximum, 13ºC minimum), during Summer is (38ºC maximum, 21.4ºC minimum) and during Autumn is (34.3ºC maximum, 17.9ºC minimum). (See appendix 4)

**Table .2.**

**The average of annual rain fall /per/ mm in Nyala station from 1999-2005**

| **The year** | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| **Nyala Station** | 480.6 | 397.4 | 286.2 | 311.1 | 552.4 | 268.00 | 494.00 |

See appendix .1.

### 2.4 Animals

In this study three local dairy breeds of cows native to South Darfur State were employed (n = 193 cows). These breeds were, Kenana breed, n = 72 Fellata breed n = 60 and cross bred (Kenana × Friesian) n = 61. The BCS of these cows vary between 2.5-4, according to the scale described by Wildman, *et al*., (1982). Their parity range was between 1 to 5.

#### 2.4.1 Management and feedin

The Kenana and Fellata cows were kept under semiclosed system of management. During the day the cows were allowded to graze on the surroundings from 10:00 am and flocked back at 4: 00 pm. They were fed rouphages and concentrate mixture which is composed of Sorghum (Sorghum Vulgare vr Fetarita) 35%, ground nut cake 30% wheat bran 33%

and Sodium chloride 2%. The Kenana and Fellata were fed 3-4 kg concentrate once a day in the afternoon during the milking period.

The cross-bred cows were kept under closed system of management. They were fed dairy concentrate mixture at a rate of 5kg / cow in the morning and 5kg/cow in the afternoon. The concentrate mixture is composed of 38% Sorghum, (Sorghum Vulgare vr Fetarita) 30% groundnut cake 30% wheat bran and 2% sodium chloride. They were fed green fodder Abu70 (Sorghum, bicolor), Barseem (Alfa Alfa) and roughages.

After parturition, the new-born calves were left with their dams for 7 days and thereafter they were left to suckle their mothers twice a day in the morning and in the afternoon.

### 2.4.2 Housing :

The animals were kept in an open shaded yards. The open shaded yards were constructed mainly from local materials. The pens were made from wooden bars and the roof was from locally made wooden sheets. The floor was covered with sand. The pregnant animals were kept in separate yards.

### 2.4.3 Milking:

The average daily milk production during the first 90 days postpartum was 3-5 lb/day for Fellata breed, 10-12 lb/day for Kenana breed and 20-30 lb for cross-bred cows. After parturition the dams were left to suckle their calves twice daily till the end of lactation period which ranged between 6-7 months. Milking was done manually by the herd men.

### 2.4.4 Heat detection

All the cows in the herds were checked for oestrous signs by visual observations by well trained herdsmen three times a day postpartum, early in the morning at 7:00 am, in the mid day at 12:00 and at 6:00pm for at least 30 minutes. The cow was recorded in heat when it becomes restless, licks the perineum of other cows, jumps on other cows, allow other cows or bull to mount her, it bellows and there is a transparent clear mucous drops from her vulvae. The cow was considered, in a full response when it stands to be mounted by the bull and mating was completed. (Arthur, *et al*. 1998).

### 2.4.5 Health control.

Routime vaccination against the common major diseases Haemorrhagic Septicemia (HS), Black quarter (BQ), Anthrax and Contagious Bovine Pleuropnemonia (CBPP), was done once yearly. Routine testing for brucellosis was done yearly under the control of the Regional Veterinary Research Lab. Routine mastitis testing was done for the suspected cows. The udder was washed with water and after milking the teats of the udder were emerced in a suitable antiseptic solution like (potassium permanganate 1:1000). During the last week prepartum the pregnant cows were injected with streptomycin 20% to prevent postpartum mastitis. They were also treated with local intramamry antibiotic to reduce the incidence of mastitis during the dry period. The commonly used antibiotic in the farms as treatment of respiratory infections was oxytetracycline at a dose rate of 50 mg/ 5-10 kg. b.w. (Limoxin -50

Interchemec Holland). The cows were drenched Anizole-100 suspension 10 mg/ kg b.w. (Anglian Nutrition Products Company United Kingdom) the shades were routinely sprayed with acaricidal drugs.

## 2.5 Experimental design:-

### 2.5.1 Experiment -I-

This experiment was a simple factorial design to study the breed effect on the PPI of three Sudanese dairy breeds of cattle native to South Darfur State. The length of the PPI was studied by visual observations. A total of 59 dairy cows calved between January 2003-Abril 2004 were selected according to the scale of the BCS after calving. The cows with BCS below 2.5 were excluded. The general range of the BCS for the cows used in this experiment was between 2.5 -4 with parity between 1-5. The cows were grouped into three groups according to their breeds, Kenana (n = 21), Fellata (n = 17) and cross-bred (Kenana × Friesian) (n = 21) cows. The length of the PPI was calculated from the day of parturition until the appearance of the first signs of the first oestrus postpartum. Furthermore, the influences of BCS and parity on the PPI were investigated.

### 2.5.2 Experiment -II-

This experiment was a 3×2 factorial design to study the possibility of reducing the length of the PPI of the three local breeds of dairy cattle Kenana, Fellata and cross-bred native to south Darfur State treated with gonadotrophic releasing hormone (GnRH) on day 21 postpartum. A total of (n = 66) dairy cows were selected for this experiment. The scale of the BCS for the cows used in this experiment ranged between 2.5-4 after calving, the parity ranged between 1-5. The cow with BCS less than 2.5 were excluded. The cows were grouped into two groups, group I was the treatment group (n = 33) and group II was the control (n = 33). Group I was subgrouped into three groups according to their breed, Kenana (n =11) Fellata (n = 11) and cross-bred (Kenana × Friesian) (n = 11) cows. Every cow from group I was intramuscularly injected with 250µg of synthetic GnRH (Fertagyl, Intervet International B.V. Boxmeer, Hollanda) on day 21 after calving (Elzubeir and Elshiekh, 2004). Group II was untreated to serve as control. The length of the PPI was calculated from the day of parturition till the appearance of the signs of the first oestrus postpartum.

### 2.5.3 Experiment -III-

This experiment was a 3×3 factorial design to study the effect of season of calving on the length of the PPI of the dairy cows native to South Darfur State. The total number of cows used in this experiment was 68 dairy cows, they were grouped into three groups according to the breed, Kenana (n = 29) cow, Fellata (n = 21) cow and cross bred (Kenana × Friesian) (n = 28) cow. Each group was further sub grouped according to the season of parturition. The cows that calved in Summer season were (n = 25) dairy cows, Kenana (n = 7), Fellata (n = 4) and cross bred (n = 14) cows. The cows that calved in Winter season were (n = 31) dairy cows, Kenana (n = 13), Fellata (n = 11) and cross-bred (n = 7) cows. The cows that calved in Autumn season were (n = 22) cows, Kenana (n = 9), Fellata (n = 6) and cross-bred (n = 7) cows. The BCS of the cows used in this experiment was between 2.5-4 after parturition. The length of the PPI was calculated from the day of parturition until the appearance of the signs of the first oestrus postpartum.

### 2.6 Statistical analysis

Data are means ± SE. The data were subjected to ANOVA followed by Fisher's protected least significant difference. Differences at probability of $P<0.05$ were considered statistically significant. The relation between the BCS and the PPI, and parity and PPI were blotted using the regression blot.

## Results

### 3.1 Experiment .I.

#### 3.1.1 The effect of the breed on the length of the PPI.

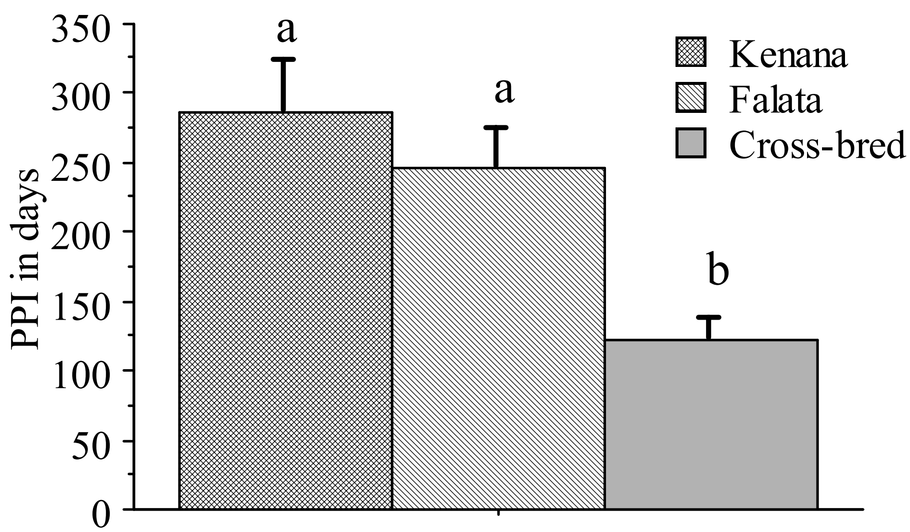
As shown in **Fig. 1**. breed significantly ($P<0.001$) affects the length of the PPI. The cross-bred dairy cows had a shorter PPI (122.00 ± 14.9 days) compared to the kenana breed (286 .9 ± 35.3 days) and the Fellata breed (246.26 ± 26.6 days). No significant difference ($P>0.05$) was observed between the kenana and the Fellata breed.

#### 3.1.2 The relation between the BCS and the PPI.

As shown in **Fig. 2.** there was a slight negative relation between the BCS and the length of the PPI ($R=0.2$). When the BCS increases the length of the PPI decreases.

#### 3.1.3 The relation between the parity and the PPI.

As shown in **Fig. 3**. parity has no influence ($R=0.005$) on the PPI of the different breeds of cows, however when the number of parities increases the PPI decreases.



350
300
250
200
150
100
50
0
PPI in days
a
a
b
Kenana
Falata
Cross-bred

**Fig. 1**. Postpartum interval in three different dairy breeds bred in South Darfur state. [a, b] Values differed at $p<0.001$.

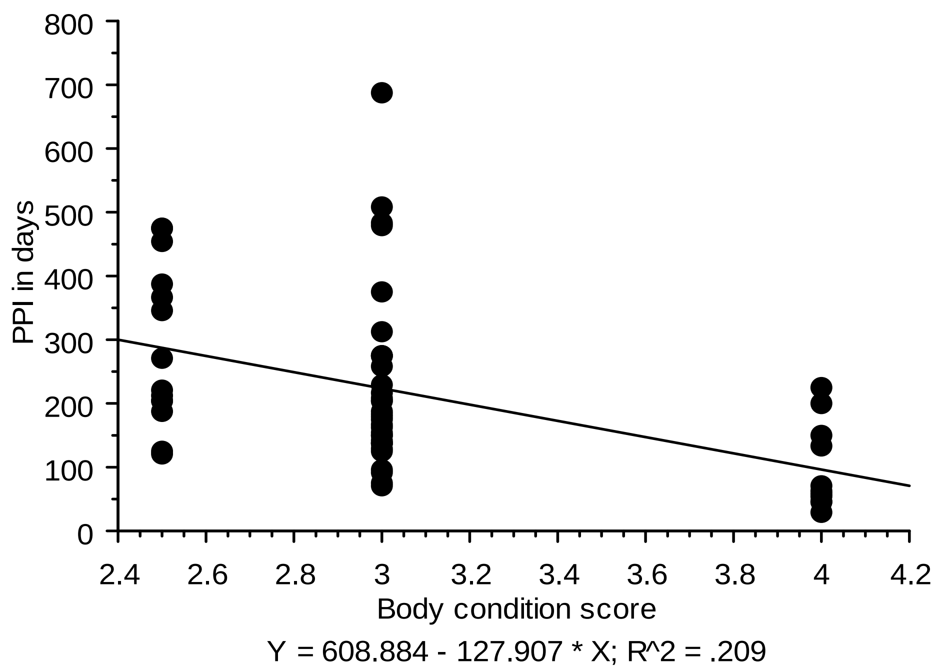


**Fig. 2**. The relation between the BCS and the length of the PPI of the local breeds Kenana, Fellata and cross-bred dairy cows.

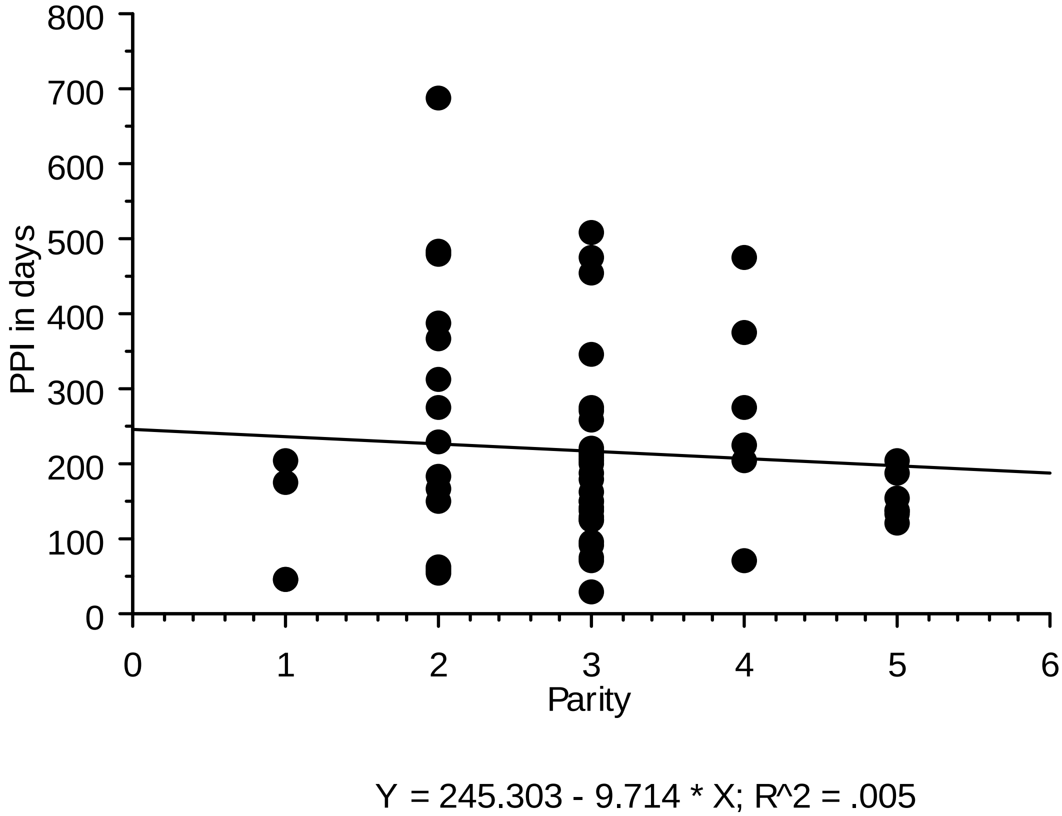



**Fig. 3.** The relation between parity and the length of the PPI of the local breeds Kenana, Fellata and cross-bred dairy cows.

## 3. 2 Experiment -II-

**The effect of treatment with GnRH on day 21 postpartum on the length of the PPI.**

The results of this experiment showed that there was no interaction ($P>0.05$) between the breed and treatment. Treatment with GnRH significantly ($P<0.001$) reduces the length of the PPI in all breeds of cows (Kenana, Fellata and Cross bred). The length of the PPI of the Kenana cows treated with GnRH on day 21 postpartum was 79.5 ± 8.4 days and the control Kenana cows was 276.5 ± 54.4 days. (**Fig. 4**). The PPI of Fellata cows treated with GnRH on day 21 postpartum was 65.9 ± 3.2 days while that of the control Fellata cows was 266.4 ± 38.7 days. (**Fig. 5**.)

**Fig. 6.** Explains that the PPI of the treated cross-bred cows was 74.2 ± 2.8 days, while that of the control cross-bred cows was 151.9 ± 18.5 days.

Also the results showed no significant ($P>0.05$) difference among the treated cows of the different breeds.

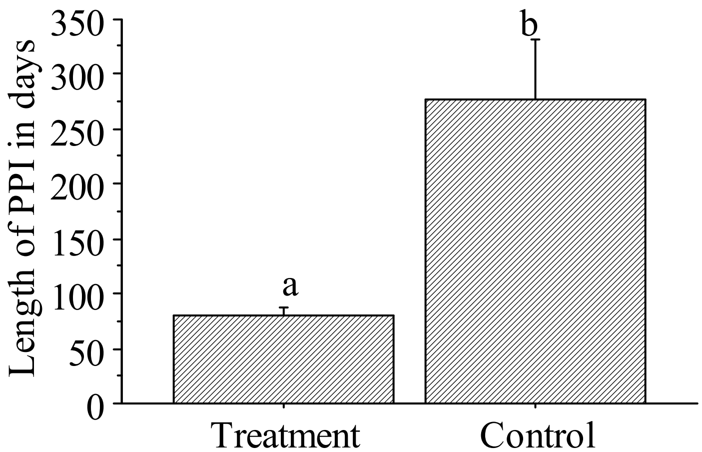



**Fig.4**. The effect of GnRH treatment on day 21 postpartum on the length of PPI of Kenana cows. [a, b] Values differed significantly at $p<0.001$.

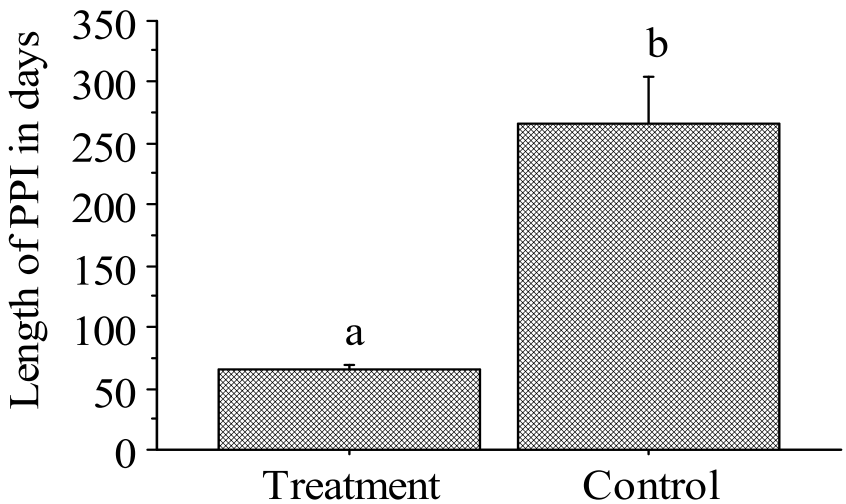



**Fig.5**. The effect of GnRH treatment on day 21 postpartum on the length of PPI of Fellata cows. [a, b] Values differed significantly at $p<0.0001$.

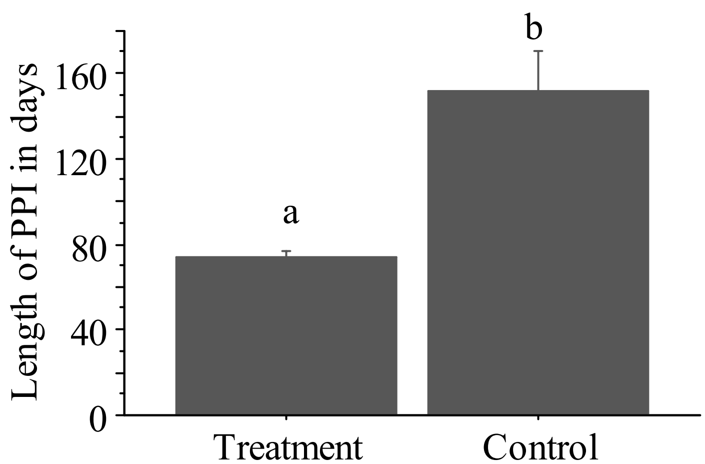



**Fig. 6**. The effect of GnRH treatment on day 21 postpartum on the length of PPI of cross-bred cows. [a, b] Values differed significantly $p<0.001$.

## 3.3Experiment -III-

**Effect of the season on the PPI**

As shown in **Fig. 7**. the season significantly influences the PPI of cross-bred cows ($P<0.001$) and it has slight effect on the PPI of Kenana, and Fellata cows. The cross bred cows in Summer expressed a significantly ($P<0.01$) short PPI compared to Winter and Autumn.

The length of the PPI of Kenana cows during Winter, Summer and Autumn were, 276.4 ± 46.9 days, 214.60.0 days, 223.5 ± 31.6 days, respectively. The length of the PPI of Fellata cows during Winter, Summer and Autumn were, 286.5 ± 38.7 days, 200.8 ± 30.4 days and 223.2 ± 22.9 days respectively. The length of the PPI of cross-bred cows during Winter, Summer and Autumn were, 153.1 ± 17.5 days; 46.14 ± 5.1 days and 160.5 ± 29 days respectively.

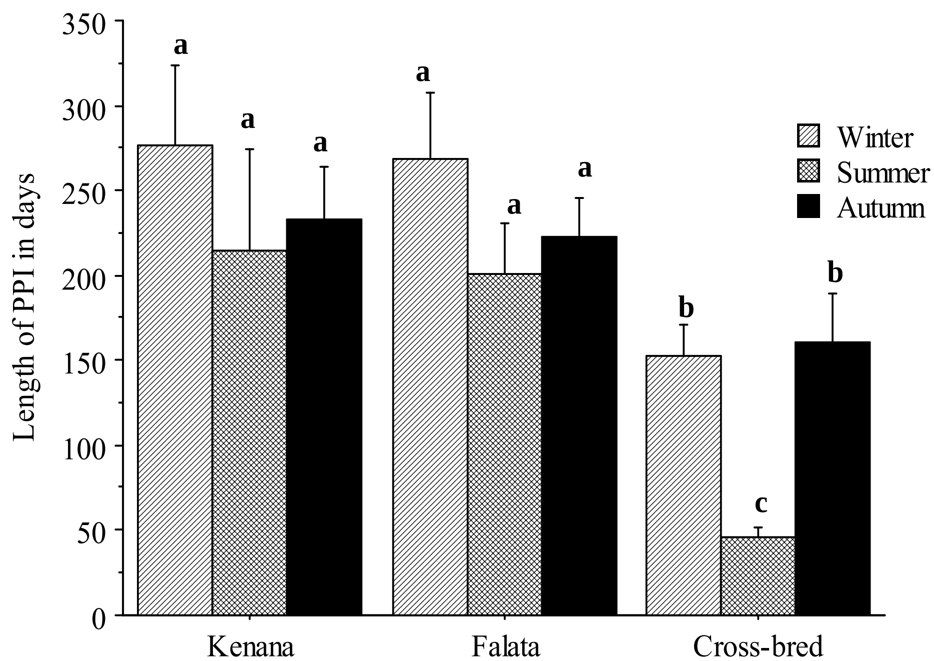



**Fig. 7**. The effect of the season on the length of the PPI of the three breeds, Kenana, Fellata and cross bred dairy cows.
[a, b, c] Values differed significantly at (P>0.01).

# Chapter -4-

## Discussion

In the present study it was found that the cross-bred dairy cows had a shorter PPI than the pure local breeds, namely Kenana and Fellata cows native to South Darfur State. It has now became evident that the reproductive performance has been decreasing in the high yielding cows. A large number of studies have indicated that milk yield and genetic merits for milk production are negatively associated with fertility traits (Campos, *et al*. 1997.; Hoekstra, *et al*.1984; Pryce, *et al*. 1997). Other studies have found that the reproductive function during the early postpartum period is reduced in animals with high genetic merit or high milk yield (Beam and Butler, 1997; Snijers, *et al*. 2001). Although it is well known that the temperate dairy cows produce large amount of milk compared to the zebu cows, the length of their PPI is shorter than that of zebu cows. In the current study the cross-bred dairy cows used were produced by crossing of Friesian with Kenana to increase the genetic merits for milk production. Results from the present studies have provided evidence that cross-bred dairy cows having Friesian blood have a shorter PPI compared to the Bous indicus cows namely Kenana and Fellata dairy cows native to Sudan. Although the two pure native breeds of cows used in the current study produce less milk than the cross- bred cows used. Their reproductive function during early postpartum is slow than that of the cross-bred cows. It seems that the negative relation between increasing genetic merit and the reproductive function during early postpartum in the previous studies takes place only when selection for improvement is carried out within the same breed. However, results from the present study shown that up grading of zebu cows with Friesian to increase their genetic merit for milk yield, reduced their PPI and did not increase it. This finding indicated that there exists a genetic factor in temperate cows not related to milk yield that makes them have a shorter PPI.

It has been proposed that the reproductive performance is influenced by the negative energy balance during early lactation (Staple, *et al*.1990; Beam and Butler, 1997). Owing to the difference between dietary energy intake and requirement for milk production, dairy cows experience a period of negative energy balance during early lactation which results in mobilization of body fat reserve (Peters and Riley, 1982). The extent for negative energy balance is normally related to the milk yield (Butler and Smith, 1989; Beam and Butler, 1997). Several studies have shown that the negative energy balance status can significantly influence functional characteristic of ovarian follicular development during early postpartum period and therefore affects the resumption of oestrous cycles, interval from calving to the first ovulation and subsequent fertility (Staples, *et al*.; 1990; Lucy, *et al*. 1992; Beam and Butler, 1997; Kruip, *et al.* 1998). The negative energy balance that leads to mobilization of body fat reserve is associated with changes in BCS score. The cows that loose more fat will have a less

BCS. The results of the current study showed that there is a slight negative relation between the length of the PPI and the BCS. That is to say the cows that their BCS decreases during early postpartum will express a longer PPI compared to the cows that their BCS remains stable. However, other studies have reported that the PPI to first oestrus in not related to energy balance of the cow (Villa-Godoy, *et al*. 1988.; Snijders, *et al*. 2001) and that the BCS from calving to first service are not related to conception in high genetic merit cows (Snijders, *et al*. 2001). The difference between these studies and the present study was probably due to differences in metabolic hormone profile which is known to influence the resumption of oestrous cycle during early postpartum.

Postpartum ovulation occurred earlier in cows that had calved more than twice compared to cows that calved twice or less (Eduvie, 1985). The primparous cows took longer time to return to first oestrus postpartum than did pluriparous cows (Mukasa, *et al*. 1991). The shortest time taken for occurrence of first oestrus was reported to be at the $3^{rd}$ - $4^{th}$ calving, the moderate period was at the $5^{th}$ - $6^{th}$ calving and the longest time taken was at $9^{th}$ - $10^{th}$ calving (Elhag, 2003). The findings of the present study indicated that the parity has no effect on the length of the PPI of dairy cows native to South Darfur State, these findings disagree with the above mentioned studies. This difference may be due to the range of parity used for the present study which was between $1^{st}$ to $5^{th}$ calving, where that of the above studies may extend to $10^{th}$ calving. Additionally, the cattle owners in South Darfur State used to breed their heifers at the age of 3 years or above, consequently the age at $1^{st}$ calving of the cows native to South Darfur State will be different from those cows used in the above studies. The age at 1st calving of the cows in the above mentioned studies was about 2.5 years.

Administration of GnRH during early postpartum causes an acute increase in gonadotropins level (FSH and LH) that stimulate folliculogenesis, induce ovulation of the selected large follicle and increase oestrogen concentration in the plasma (Hafez, 1993). Oestrogen is known to have a bactericidal effect that reduces infection during postpartum period resulting in a faster uterine involution and a reduced PPI (Thatcher, *et al*. 1993). A single injection of GnRH during the 1st, the 2nd or 3rd week postpartum reduced the time taken for recrudescence of the postpartum first oestrus in cross-bred (Friesian × Kenana), Sudanese dairy cows (Elzubeir and Elsheikh, 2004). Early postpartum administration of GnRH initiated the postpartum ovarian cyclic activity and reduced the PPI (Yavas and Walton, 2000). The GnRH and its agonist analogues act on ovarian follicular development and CL function indirectly via the induced release of pituitary LH and FSH that stimulates ovarian activity leading to reduction of the length of the PPI (Conn and Crowly, 1991). In the present study injection of GnRH on day 21 postpartum reduced the length of the PPI. This result agrees with the finding of the above mentioned studies. Contrary (Thatcher, *et al*; 1993; Foote and Rick, 1999) reported that injection of GnRH during early postpartum has no effect on the reproductive efficiency on the time elapsed from parturition to the occurrence of first oestrus. These discrepancies are probably due to differences in the time of GnRH administration which was carried on day 21 postpartum in this study and in the above studies, the time of administration of GnRH was before the 3rd week postpartum. Also the effect of breeds employed could not be ignored.

Seasonal changes in temperature and photoperiod are known to influence the timing of recrudescence of the first oestrus postpartum (Hafez, 1993). Along postpartum period was reported in cows that delivered in Winter and early spring than those delivered in Autumn and Summer (Peter and Riley 1982). The same authors reported a long PPI in cows calved in Spring compared to cows calved in Autumn. Furthermore, Peter and Riley reported that expression of the first postpartum oestrus during Winter is lower than it is expression in Summer. In the current study the pure local cows namely Kenana and Fellata cows showed similar PPI among all seasons. However the cross-bred dairy cows in the current study expressed a shorter PPI during Summer compared to Winter and Autumn. The findings of the cross-bred cows agree with the above mentioned studies. Minor discrepancies may occur between the findings of this study and the above mentioned studies because in South Darfur State there are only three seasons during the year of which Winter is very short and not well pronounced and there is no Spring season. These difference (namely breeds and seasons differences) may also act individually or cooperatively to make the length of the PPI of the pure local cows looks similar in all seasons of the year.

# Conclusion

From the present study it concluded that:

- Kenana cows bred in South Darfur State have a mean PPI of 286.9 ± 35.3 days.
- Fellata cows have a mean PPI of 246.3 ± 26.6 days.
- Cross-bred dairy cows native to South Darfur State have a mean PPI of 122.0 ± 14.9 days.
- Local dairy cows having foreign blood have a shorter PPI than pure local breeds.
- The BCS has a slight negative relation with the length of the PPI. When the BCS increases the length of the PPI decreases.

- Parity up to 5 has no effect on the length of PPI of Kenana, Fellata and cross bred dairy cows native to South Darfur State.
- The season has no effect on the PPI of pure local cows namely Kenana and Fellata.
- The PPI of cross-bred dairy cows native to South Darfur State is affected only by Summer season. While no effect of Autumn and Winter on PPI of the cross- bred dairy cows was recognized.
- Increasing the genetic merits for milk yield by crossing the local breed of cows with foreign breeds reduces the length of PPI.
- Injection of GnRH on day 21 postpartum reduces the length of PPI of all breeds.

## Recommendations:

1- To obtain dairy cows that have a short PPI and capable for producing a calf per year, the local dairy cows native to South Darfur State should be up graded with foreign breeds of cows.

2- The BCS of the cows during pregnancy should be above three to avoid the loss in the body weight during early postpartum that leads to a longer PPI.

3- A program of administration of GnRH after the 3$^{ed}$ week postpartum is recommended to reduce the length of the PPI.

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**Appendix .1.**

**The average of rain fall /per/ mm in Nyala station from 1999-2005**

**(Nyala Metrological office)**

| **The year** | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| **Nyala Station** | 480.6 | 397.4 | 286.2 | 311.1 | 552.4 | 268.00 | 494.00 |

## Appendix .2.

**Population of livestock in South Darfur State.**

**Appendix.3.**

**Appendix .4.**

**Appendix .5.**

**Different parameters of PPI of local dairy cows native to South Darfur State**

| No | Breed | BCS | Parity | PPI |
|---|---|---|---|---|
| 1 | Kenana | 3 | 2 | 688 |
| 2 | Kenana | 3 | 2 | 485 |
| 3 | Kenana | 3 | 5 | 155 |
| 4 | Kenana | 3 | 2 | 313 |
| 5 | Kenana | 3 | 3 | 123 |
| 6 | Kenana | 3 | 3 | 92 |
| 7 | Kenana | 3 | 5 | 186 |
| 8 | Kenana | 3 | 2 | 273 |
| 9 | Kenana | 3 | 3 | 189 |
| 10 | Kenana | 3 | 3 | 180 |
| 11 | Kenana | 2.5 | 2 | 388 |
| 12 | Kenana | 3 | 2 | 268 |
| 13 | Kenana | 2.5 | 3 | 212 |
| 14 | Kenana | 2.5 | 3 | 152 |
| 15 | Kenana | 2.5 | 3 | 138 |
| 16 | Kenana | 3 | 3 | 138 |
| 17 | Kenana | 3 | 3 | 455 |
| 18 | Kenana | 3 | 5 | 360 |

| | | | | |
|---|---|---|---|---|
| 19 | Kenana | 2.5 | 3 | 276 |
| 20 | Kenana | 2.5 | 3 | 203 |
| 21 | Kenana | 2.5 | 4 | 216 |
| 22 | Fellata | 2.5 | 5 | 203 |
| 23 | Fellata | 3 | 3 | 216 |
| 24 | Fellata | 2.5 | 3 | 221 |
| 25 | Fellata | 2.5 | 5 | 121 |
| 26 | Fellata | 2.5 | 3 | 124 |
| 27 | Fellata | 2.5 | 4 | 205 |
| 28 | Fellata | 2.5 | 3 | 345 |
| 29 | Fellata | 4 | 4 | 225 |
| 30 | Fellata | 3 | 3 | 310 |
| 31 | Fellata | 3 | 4 | 275 |
| 32 | Fellata | 3 | 3 | 210 |
| 33 | Fellata | 3 | 2 | 478 |
| 34 | Fellata | 3 | 3 | 274 |
| 35 | Fellata | 3 | 2 | 166 |
| 36 | Fellata | 3 | 5 | 138 |
| 37 | Fellata | 2.5 | 3 | 271 |
| 38 | Fellata | 3 | 3 | 203 |
| 39 | Cross-bred | 4 | 5 | 132 |
| 40 | Cross-bred | 3 | 2 | 184 |
| 41 | Cross-bred | 3 | 3 | 97 |
| 42 | Cross-bred | 3 | 2 | 229 |
| 43 | Cross-bred | 3 | 3 | 260 |
| 44 | Cross-bred | 3 | 3 | 74 |
| 45 | Cross-bred | 4 | 3 | 151 |
| 46 | Cross-bred | 3 | 3 | 140 |
| 47 | Cross-bred | 3 | 3 | 131 |
| 48 | Cross-bred | 3 | 4 | 71 |
| 49 | Cross-bred | 4 | 3 | 202 |
| 50 | Cross-bred | 3 | 1 | 173 |
| 51 | Cross-bred | 3 | 1 | 204 |
| 52 | Cross-bred | 3 | 2 | 152 |
| 53 | Cross-bred | 4 | 2 | 56 |
| 54 | Cross-bred | 4 | 1 | 44 |
| 55 | Cross-bred | 4 | 2 | 57 |
| 56 | Cross-bred | 4 | 2 | 70 |
| 57 | Cross-bred | 4 | 2 | 62 |

| | | | | |
|---|---|---|---|---|
| 58 | Cross-bred | 4 | 1 | 44 |
| 59 | Cross-bred | 4 | 3 | 30 |

**Appendix .6.**

**PPI of local breeds of dairy cows native to South Darfur State treated with GnRH**

| No | treatment | Kenana | Fellata | Cross-bred cows |
|---|---|---|---|---|
| 1 | treatment | 76 | 58 | 86 |
| 2 | treatment | 60 | 77 | 84 |
| 3 | treatment | 90 | 63 | 63 |
| 4 | treatment | 31 | 64 | 77 |
| 5 | treatment | 79 | 55 | 71 |
| 6 | treatment | 30 | 80 | 83 |
| 7 | treatment | 58 | 57 | 64 |
| 8 | treatment | 57 | 69 | 68 |
| 9 | treatment | 111 | 55 | 60 |
| 10 | treatment | 126 | 85 | 81 |
| 11 | treatment | 107 | 62 | 79 |
| 12 | Control | 161 | 216 | 132 |
| 13 | Control | 377 | 221 | 184 |
| 14 | Control | 688 | 121 | 97 |
| 15 | Control | 485 | 124 | 229 |
| 16 | Control | 155 | 205 | 260 |
| 17 | Control | 313 | 345 | 74 |
| 18 | Control | 123 | 225 | 151 |
| 19 | Control | 92 | 510 | 140 |
| 20 | Control | 186 | 275 | 131 |
| 21 | Control | 273 | 210 | 71 |
| 22 | Control | 189 | 478 | 202 |

**Appendix .7.**

**The length of PPI of local dairy cows native to South Darfur State during the three different seasons**

| No | Breed | Winter | Summer | Autumn |
|---|---|---|---|---|
| 1 | Kenana | 92 | 212 | 168 |
| 2 | Kenana | 161 | 152 | 277 |
| 3 | Kenana | 377 | 138 | 421 |
| 4 | Kenana | 688 | 476 | 155 |
| 5 | Kenana | 485 | 388 | 123 |
| 6 | Kenana | 155 | 76 | 189 |
| 7 | Kenana | 313 | 60 | 267 |
| 8 | Kenana | 123 | | 180 |
| 9 | Kenana | 186 | | 313 |
| 10 | Kenana | 276 | | |
| 11 | Kenana | 189 | | |
| 12 | Kenana | 180 | | |
| 13 | Kenana | 386 | | |
| 14 | Fellata | 203 | 225 | 138 |
| 15 | Fellata | 261 | 274 | 271 |
| 16 | Fellata | 121 | 166 | 203 |
| 17 | Fellata | 124 | 138 | 186 |
| 18 | Fellata | 205 | | 273 |
| 19 | Fellata | 221 | | 286 |
| 20 | Fellata | 345 | | |
| 21 | Fellata | 478 | | |
| 22 | Fellata | 210 | | |
| 23 | Fellata | 510 | | |
| 24 | Fellata | 275 | | |
| 25 | Cross-bred | 151 | 30 | 132 |
| 26 | Cross-bred | 140 | 45 | 184 |
| 27 | Cross-bred | 131 | 33 | 97 |
| 28 | Cross-bred | 71 | 61 | 229 |
| 29 | Cross-bred | 202 | 45 | |
| 30 | Cross-bred | 173 | 42 | |
| 31 | Cross-bred | 204 | 67 | |

**Appendix .8.**

**The effect of the season on the PPI of Kenana, Fellata and cross-bred dairy cows.**

| Breed | Summer | Winter | Autumn |
|---|---|---|---|
| Kenana | 214.57±60.00 | 276.39±45.9 | 233.56±31.8 |
| Fellata | 200.75±30.4 | 268.46±38.7 | 233.18±22.9 |
| Cross-bred | 46.00±6.5 | 153.14±17.4 | 160.00±28.9 |

**Appendix .9.**
**Kenana breed dairy cows**:-

| The name of the cow | Parity | B.C.S | Day of part. | PPI | Day of conception | Repeat breeding |
|---|---|---|---|---|---|---|
| WIZEAN | 3 | 3 | 20.12.2001 | 161 day | 30.5.2002 | |
| ARDA | 4 | 3.5 | 26.12.2001 | 377 day | 7.2.2003 | |
| DOWMA | 2 | 4 | 20.12.2001 | 688 day | 10.11.2002 | |
| SAFRA | 2 | 2.5 | 1.1.2002 | 485 day | 1.5.2003 | |
| BASHOM | 5 | 2.5 | 5.1.2002 | 155 day | 9.6.2002 | Rep. Breeding 1.7.2002 |
| ALTANMIN | 2 | 3 | 6.1.2002 | 313 day | 15.11.2002 | |
| ARIAL | 3 | 3 | 2.1.2002 | 123 day | 5.7.2002 | |
| BASKAWIT | 3 | 2.5 | 16.11.2001 | 92 day | 16.2.2002 | |
| HORA | 5 | 3 | 5.1.2002 | 186 day | 10.7.2002 | |
| HAMAN | 2 | 2.5 | 5.1.2002 | 273 day | 5.10.2002 | |
| OMATIMAN | 3 | 2.5 | 23.1.2002 | 189 day | 31.7.2002 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| OMATIMAN | 3 | 3 | 5.2.2002 | 180 day | 4.8.2002 | |
| GARA | 2 | 2.5 | 11.3.2002 | 388 day | 3.2.2002 | |
| BIT DOWMA | 2 | 2.5 | 6.2.2002 | 368 day | 1.2.2003 | |
| $SAFARA_2$ | 3 | 2.5 | 1.3.2002 | 212 day | 3.8.2002 | |
| KINANA | 3 | 3 | 30.3.2002 | 152 day | 1.9.2002 | |
| DANG KOWAL | 3 | 3 | 28.3.2002 | 138 day | 16.8.2002 | |
| HAMAM | 5 | 3 | 4.4.2002 | 138 | 20.8.2003 | |
| BKALIL | 3 | 2.5 | 2.10.2003 | 455 | 1.4.2004 | |
| KALL | 3 | 2.5 | 20.10.2003 | 467 | 1.2.2004 | |
| $SAIRA_2$ | | | | | | |
| KENANA | 4 | 2.5 | 10.1.2003 | 47.6 | 30.4.2004 | |

## Appendix .10.
## Fellata breed dairy cows

| The name of the cow | Parity | B.C.S | Day of part. | PPI | Day of conception | Repeat breeding |
|---|---|---|---|---|---|---|
| KADRA | 5 | 2.5 | 7.11.2001 | 2.3 day | 29.4.2002 | 12.6.2002 |
| BIIKADRA | 3 | 3 | 13.11.2001 | 216 day | 2.8.2002 | |
| OMRAS | 3 | 2.5 | 6.12.2001 | 221 day | 15.7.2002 | |
| GALHA | 5 | 2.5 | 5.11.2001 | 121 day | 6.3.2002 | |
| FERY | 3 | 2.5 | 12.11.2001 | 124 day | 16.3.2002 | |
| BIT WIZIEAN | 4 | 2.5 | 13.11.2003 | 205 day | 5.6.2002 | |
| ARNAB | 3 | 2.5 | 15.12.2001 | 345 day | 27.11.2002 | |
| AL NIEA | 4 | 4 | 20.3.2002 | 225 day | 1.11.2003 | |
| FEREY | 3 | 3 | 8.11.2002 | 510 day | 1.4.2004 | |
| GILAHA | 4 | 3 | 1.12.2002 | 275 day | 3.10.2003 | |
| ALTAHER | 3 | 3 | 2.11.200 | 210 day | 31.5.2003 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | | | 2 | | | |
| ALTAHER 2 | 2 | 3 | 28.2.202 | 478 day | 25.5.2003 | |
| SAFRA | 3 | 3 | 1.3.2003 | 274 day | 30.11.2003 | |
| OMGHIRAIEN | 2 | 2.5 | | | | |
| OMGHIRAIEN | 2 | 3 | 2.3.2003 | 166 day | 15.8.2003 | |
| HAMAM | 5 | 3 | 4.4.2002 | 138 day | 20.8.2003 | |
| SIGAIRA | 3 | 2.5 | 15.7.2003 | 271 day | 13.4.2004 | |
| HAWA | 3 | 3 | 20.7.2003 | 203 day | 10.2.2004 | |

## Appendix .11.
## Cross-bred:-

| The name of the cow | Parity | B.C.S | Day of part. | PPI | Day of conception | Repeat breeding |
|---|---|---|---|---|---|---|
| ZARFGA | 5 | 3.5-4 | 15.10.2001 | 132 day | 26.2.2002 | |
| GIRAYBA | 2 | 3 | 13.12.2001 | 184 day | 15.6.2002 | |
| HAMAMA | 3 | 3 | 20.12.2001 | 97 day | 27.3.2002 | |
| FORSA | 2 | 3 | 23.12.2001 | 229 day | 9.8.2002 | |
| HORA | 3 | 3 | 1.1.2002 | 260 day | 17.9.2002 | |
| OMGASH | 3 | 3 | 20.12.2001 | 74 day | 4.3.2002 | |
| ZIRAG | 3 | 3.5-4 | 1.1.2002 | 151 day | 5.6.2002 | |
| OMSAIER | 3 | 3 | 25.12.2001 | 140 day | 5.5.2002 | |
| KARASI | 3 | 3 | 27.1.2002 | 131 day | 10.5.2002 | |
| OMSAMGOR | 4 | 3 | 25.2.2002 | 71 day | 5.5.2002 | |
| KOSTL | 3 | 3.5-4 | 25.2.2002 | 202 day | 15.8.2002 | |
| GAZAL | 1 | 3 | 28.2.2002 | 173 day | 20.8.2002 | |
| KAMSA | 1 | 3 | 24.2.2002 | 204 day | 21.9.2002 | |
| SORA | 2 | 3 | 13.4.2002 | 152 day | 17.9.2002 | |
| SALIGA | 2 | 3.5-4 | 10.3.2002 | 56 day | 5.5.2002 | |
| BOLOWZA | 1 | 3.5-4 | 22.4.2002 | 44 day | 5.6.2002 | |
| GADIDA | 2 | 3.5-4 | 15.3.2002 | 57 day | 12.5.2002 | 2.6 |
| HEMAIER | 3 | 3.5-4 | 17.3.2002 | 70 day | 26.5.2002 | Rep |
| TAHNIA | 2 | 3.5-4 | 17.32002 | 62 day | 3.5.2002 | Rep |
| ONWAN | 1 | 3.5-4 | 28.3.2002 | 44 day | 11.5.2002 | Rep 23.5 |
| TAWILA | 2 | 3.5-4 | 12.4.2002 | 30 day | 12.2.2002 | Rep 6.6.2002 |
| MARYODA | 4 | 3.5-4 | 5.4.2002 | 45 day | 20.5.2002 | Rep 8.6 |
| TIKO | 1 | 3.5-4 | 18.4.2002 | 33 day | 21.5.2002 | Rep |
| ISKARTO | 1 | 3.5-4 | 25.4.2002 | | | |
| GARNOG | 1 | 3.5-4 | 22.3.2002 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| OMMASIER | 3 | 3.5-4 | 2.4.2002 | | | |
| BREAK | 3 | 3.5-4 | 24.4.2002 | | | |
| GARA | 2 | 3 | 24.4.2002 | | | |
| BIT HALOF | 2 | 3 | 1.5.2002 | | | |
| ZARAF | 3 | 3 | | | | |

**Appendix .12.**
**Kenana dairy cows treated with (GnRH)** :-

| **The name of the cow** | **Parity** | **B.C.S** | **Day of part.** | **PPI** | **Day of conception** | **Repeat breeding** |
|---|---|---|---|---|---|---|
| GARA | 3 | 3 | 14.3.2002 | 76 day | 20.6.2002 | |
| RIDINA | 5 | 3.5-4 | 23.3.2002 | 60 day | 11.6.2002 | |
| WIZEAN | 3 | 3 | 29.9.2002 | 90 day | 20.1.2003 | |
| OMMARAD | 4 | 3.5-4 | 30.9.2002 | 31 day | 31.10.2003 | |
| BITWIZEAN$_A$ | 3 | 3 | 16.2.2003 | 80 day | 30.5.2003 | |
| BITWIZAN$_B$ | 2 | 3 | 13.12.2002 | 58 day | 9.2.2003 | |
| SOMEAT | 3 | 3 | 20.12.2002 | 57 day | 15.2.2003 | |
| HINAKE | 4 | 3 | 7.3.2003 | 111 day | 27.7.2003 | |
| ASAL | 2 | 3 | 29.1.2003 | 126 day | 26.6.2003 | Rep. Br. |
| MOZA | 3 | 3 | 2.7.2002 | 107 day | 12.11.2003 | |
| BASHOM | 4 | 3 | 4.4.2003 | 76 day | 10.7.2003 | |
| KINANIA | 5 | 3 | 17.2.2003 | 89 day | 6.7.2003 | |
| ASAL$_2$ | 3 | 3 | 15.6.2003 | 106 day | 24.10.2003 | |

**Appendix .13.**
**Fellata dairy cows treated with GnRH.**

| The name of the cow | Parity | B.C.S | Day of part. | PPI | Day of conception | Repeat breeding |
|---|---|---|---|---|---|---|
| BIT WIZEAN | 5 | 3 | 10.4.2003 | 58 day | 7.6.2003 | |
| WIZA | 2 | 3.5-4 | 7.4.2003 | 77 day | 23.6.2003 | |
| KADRA | 5 | 3.5-4 | 27.4.2003 | 63 day | 30.6.2003 | |
| GMRAS | 4 | 3 | 6.5.2003 | 64 day | 9.7.2003 | |
| BIT KADRA | 4 | 3 | 8.5.2003 | 55 day | 2.7.2003 | |
| SIGAIERA | 2 | 3 | 7.8.2003 | 80 day | 27.10.2003 | |
| HAWAYA | 3 | 3.5-4 | 14.8.2003 | 57 day | 11.10.2003 | |
| HAWAYA | 2 | 3.5-4 | 26.8.2003 | 69 day | 4.11.2003 | |
| ARNAB | 4 | 3.5-4 | 13.9.2002 | 55 day | 17.11.2003 | |
| GALHA | 5 | 3 | 7.10.2003 | 85 day | 13.12.2003 | |
| FEREY | 4 | 3 | 8.1.2003 | 62 day | 10.3.2003 | |
| | 5 | | | | | |

## Appendix .14.
## Cross-bred dairy cows treated with GnRH.

| The name of the cow | Parity | B.C.S | Day of part. | Day of injection | PPI | Day of conception | Repeat breeding |
|---|---|---|---|---|---|---|---|
| GIRAYPA | 3 | 3 | 21.7.2003 | 15.8.2003 | 86 day | 16.10.2003 | |
| ADILA | 2 | 3 | 9.7.2003 | 1.8.2003 | 84 day | 2.10.2003 | |
| BIT ZARAF | 2 | 3 | 8.10.2003 | 29.10.2003 | 63 day | 10.12.2003 | |
| GINANA | 3 | 3 | 7.9.2003 | 29.9.2003 | 77 day | 23.11.2003 | |
| GAZAL | 4 | 3 | 12.10.2003 | 2.9.2003 | 71 day | 22.12.2003 | |
| KOSTI | 3 | 3 | 1.11.2003 | 22.11.2003 | 83 day | 22.1.2004 | |
| OM SANGOR | 5 | 3 | 17.11.2003 | 8.12.2003 | 64 day | 20.1.2004 | |
| ZARAL | 4 | 3 | 18.11.2003 | 9.12.2003 | 68 day | 25.1.2004 | |
| SOMEAT | 3 | 3 | 18.11.2003 | 9.12.2003 | 60 day | 17.1.2004 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SALIGA | 2 | 3 | 20.11.2003 | 11.12.2003 | 81 day | 9.2.2004 | |
| GARA | 2 | 3 | 12.12.2003 | 2.1.2004 | 79 day | 29.2.2004 | |
| TAHNIA | 2 | 3 | 17.3.2002 | | 62 day | 3.5.2002 | Rep |
| BOLOZA | 1 | 4 | 22.4.2002 | | 44 day | 5.6.2002 | Rep |